

EGSP
OPEN FILE # UGP
124

REPORT ON PHASE III OF THE MULTIVARIATE STATISTICAL
CHARACTERIZATION OF GEOCHEMICAL DATA GENERATED BY THE EGSP FOR
CORES 20403, 11940, 12041, GGS AND 7239.

by

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Introduction

This phase of the multivariate statistical characterization of geochemical data generated by the EGSP for cores 20403, 11940, 12041, GGS and 7239 marks the beginning of the sample by sample, or Q-mode, analysis. This is an important phase as the positive results obtained from this phase, when coupled with those from the remaining portion, will lead to geologically significant interpretations of the abundant data at hand.

Methods

Q-mode cluster analysis was applied to the data sets obtained from phases I and II of this project. Clustering was initiated using the unweighted pair-group method with arithmetic averages as that algorithm imparts the least structural distortion (distortion is inherent anytime one displays a multidimensional structure in 2 dimensions) to the resulting dendograms. Distortion was evaluated by the calculation of Cophenetic correlation coefficients for each of the dendograms.

Analyses were obtained for each of the 5 cores separately as well as for 3 different combined sets. The combined data sets consisted of:

1. A 309 sample by 24 variable geochemical data set for all 5 cores. Data was expressed as weight percent of the total.
2. A 268 sample by 9 variable mineralogical data set of all the cores minus GG5 as it did not have a complete mineralogical analysis. Mineralogical data was expressed as a percentage of the total peak intensity as this closely approximates weight percent (Renton, 1978).
3. A 268 sample by 33 variable data set consisting of the standardized values for the geochemical and mineralogical data for all of the cores minus GG5.

Cophenetic correlation values were obtained from the resulting 9 dendrograms. Table 1 is a listing of these values and demonstrates, due to the fact that all of the values approach 1.0, the low level of distortion obtained throughout the analysis. Characterization of the clusters was then accomplished by the calculation of mean variable abundances for each of the clusters. Constancy and fidelity values were abandoned as their binary based nature rendered them useless for this type of ordinal data; i.e., the important variables occurred in virtually all of the samples, differing only in abundances.

Results

Examination of the resulting 9 dendrograms demonstrated several important factors; firstly, the 5 separate dendrograms tend to have many outliers, that is, a large portion of the samples fail to cluster. Geologic interpretation would therefore be incomplete as many of the samples would not be included in the discussion.

Table 1

Cophenetic correlation values for the eight Q-mode dendograms

<u>Dendrogram</u>	<u>Cophenetic Correlation Value</u>
1. Core 11940	0.972
2. Core 12041	0.964
3. Core GGS	0.813
4. Core 7239	0.963
5. Core 20403	0.792
6. Total data, Geochemistry	0.932
7. Total data minus GGS, Mineralogy	0.930
8. Total data minus GGS Mineralogy + Geochemistry	0.949

More importantly, each core would have to be treated as a separate entity and an overall integration of the data would be almost impossible. Two of the combined core data sets, the geochemical and mineralogical, did have a high degree of samples that clustered (over 90%) and provide a much more geologically meaningful picture as all of the samples were compared to one another. Due to these facts the five separate dendograms and the combined standardized geochemical plus mineralogical data sets were abandoned as uninterpretable and further discussion will deal solely with the 2 remaining combined core data sets.

Examination of the 309 sample by 24 variable total geochemistry data dendrogram indicates the existence of 7 major clusters, 4 subclusters, and a small number of samples that fail to cluster. In addition, the clusters are related at a very high level of similarity (low dissimilarity), indicating an overall sameness to the samples. Table 2 is a listing of the clusters and the variables that characterize each of them. The 268 sample by 9 variable mineralogical data set can be visually divided into 6 clusters, 3 subclusters, and a small number of outliers. Again note the overall similarity of the samples to one another. A list of the clusters and the variables that characterize each of them can be found in Table 3.

Conclusions

Due to the high level of similarity (low dissimilarity) among the samples it can be concluded that there are no strong differences among the shale samples dealt with in this study. It must be noted, however, that strong differences may exist between variables that were not measured (such as Uranium).

We can separate the samples into groupings based on small differences in their variable compositions.

Some vertical and lateral segregation of the samples is apparent from visual inspection of the dendograms. Whether or not there are any systematic trends to the vertical and lateral variations will become apparent in Phase IV, when the clusters will be plotted on the stratigraphic sections.

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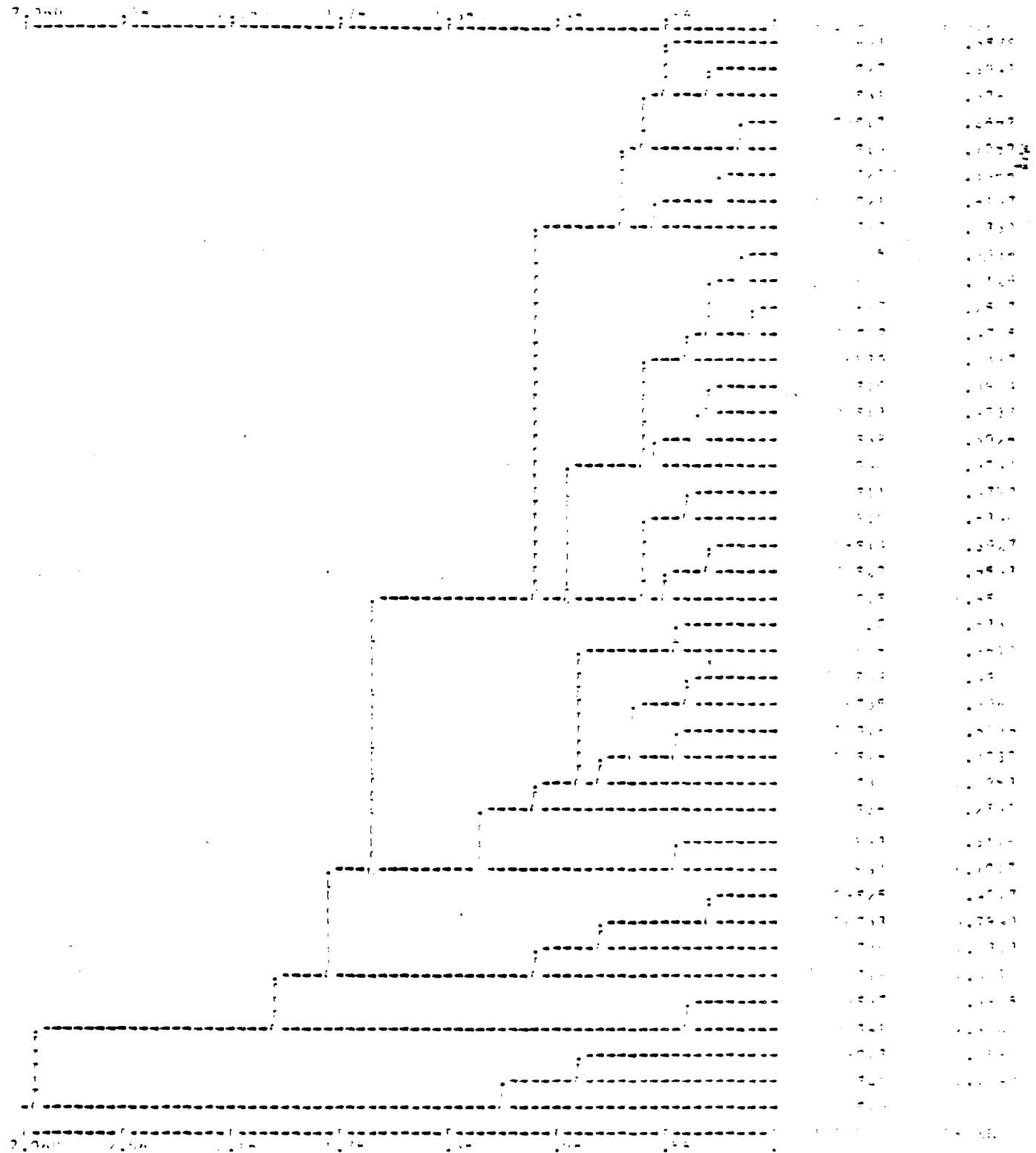
~~2,250~~ ~~7,390~~ ~~5,460~~ ~~1,160~~ ~~2,450~~ ~~1,38~~ ~~1,25~~ ~~1,17~~ ~~1,17~~

2.350 7.1% 3.450 3.350 / 3.450 3.350 3.350 3.350

PREVIOUS FROM MAYER CATERING

PHOTOGRAPHIC FILM - 35MM

Color 665 - 5 - 2000



Case 7233 - Gravest

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PHENOGHAM FROM MATRIX COTGE 200

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								A1	0.2312
								C18	0.2540
								D12	0.3534
								A78	0.3943
								B9	0.2244
								E11	0.2721
								D15	0.3215
								D14	0.2034
								E25	0.4503
								A19	0.2641
								A50	0.3665
								B53	0.4755
								A48	0.3754
								A16	0.5004
								A29	0.1933
								B10	0.3513
								A76	0.4346
								E23	0.5481
								A17	0.2749
								A59	0.2584
								A67	0.1961
								B52	0.2125
								B40	0.2922
								A78	0.3690
								A44	0.3912
								A49	0.3043
								B29	0.3297
								E15	0.4784
								A68	0.3337
								B12	0.4295

	14	0.4232
11	410	0.3564
111	442	0.7792
	421	0.2974
11	486	0.2512
	512	0.3011
	489	0.2207
111	499	0.3879
	487	0.3540
111	321	0.1984
111	539	0.2586
111	222	0.4384
	484	0.4883
	433	0.3423
	371	0.4783
	515	0.5214
	427	0.3929
	61	0.4430
11	447	0.3112
11	273	0.2931
11	357	0.3519
11	221	0.3933
	282	0.5085
	125	0.2430
11	432	0.3820
111	621	0.2900
1111	534	0.4054
111	641	0.1836
1111	546	0.2154
1111	543	0.3929
111	154	0.3423
1111	192	0.5994
11		

PHENOCARD FROM MATRIX COTG2270

II	438	0.2432
II	290	0.4300
III	493	0.3735
IV	815	0.2777
V	620	0.7386
VI	198	0.2377
VII	693	0.3110
VIII	62	0.3794
IX	650	0.2314
X	691	0.5019
XI	188	0.3944
XII	363	0.3382
XIII	56	0.5821
XIV	627	0.3903
XV	631	0.3560
XVI	487	0.2894
XVII	617	0.2562
XVIII	610	0.3681
XIX	19	0.3711
XX	426	0.4119
XI	625	0.5960
XII	443	0.2887
XIII	645	0.4733
XIV	625	0.5706
XV	600	0.3212
XVI	470	1.0049
XVII	12	0.2949
XVIII	65	0.3136
XIX	67	0.4019
XX	614	0.2955
XI	62	0.2190
XII	63	0.4752
XIII	64	0.5803

I	I	461	0.3403
I	I	422	0.3944
I	II	473	0.2039
I	II	419	0.3053
I	III	494	0.5751
I	I	45	0.1980
I	I	054	0.2815
I	I	495	0.3239
I	I	331	0.2702
I	I	337	0.2580
I	I	037	1.3790
I	I	451	0.1955
I	I	059	0.2342
I	II	461	0.3241
I	II	06	0.2079
I	III	07	0.3593
I	II	452	0.1943
I	II	343	0.2586
I	II	474	0.3043
I	II	458	0.1901
I	III	402	0.3923
I	II	469	0.3594
I	II	321	0.4852
I	II	324	0.3339
I	II	327	0.5820
I	II	322	0.2986
I	III	329	0.2941
I	II	340	0.2461
I	II	341	0.4116
I	II	328	0.3540
I	III	344	0.4043
I	II	343	0.4517

(2)

moderate hydrogen

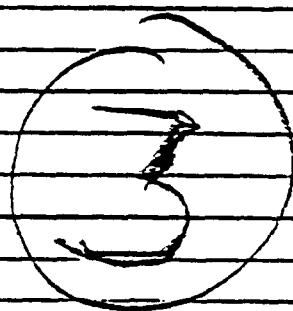
moderate - H₂

(2) 0-9 C-6-

near greater sulfur

I	IL	823	0.4494
I	III		
I	III.	049	0.3572
I	III.		
I	LLL	837	0.3194
I	L		
I	LL	933	0.7359
I	L		
I	L	475	0.7509
I	L		
I	L	939	0.3442
I	L		
I	L	412	0.1783
I	L		
I	L	457	0.3096
I	L		
II	L	038	0.1460
II	L		
II	LL	056	0.2602
II	L		
II	L	835	0.3575
II	L		
II	L	933	0.1617
II	L		
II	L	450	0.2576
II	L		
II	IL	941	0.3706
II	L		
II	IL	830	0.2498
II	L		
II	II	938	0.2926
II	II		
II	ILL	851	0.3491
II	II		
II	LL	030	0.4278
II	L		
II	L	932	0.2582
II	L		
II	LL	013	0.2482
II	L		
II	LL	055	0.4032
II	L		
II	L	034	0.5544
II	L		
II	L	324	0.3339
II	L		
II	L	934	0.3617
II	L		
II	IL	035	0.2313
II	L		
II	IL	036	0.2382
II	L		
II	IL	039	0.1960
II	L		
II	LL	048	0.4334
II	L		
II	IL	833	0.4844
II	L		
II	LL	935	0.3119
II	L		
II	L	31	0.5014
II	L		
II	L	310	0.2544
II	L		
II	L	319	0.3810

II	II	044	0.4408
II	II	911	0.3594
II	III	232	1.2756
II	III	536	0.7259
III	III	034	0.3397
II	---	350	0.3911
II	---	100	0.5224
II	I	314	0.3913
III	---	232	1.1589
I	---	C34	1.2271
I	---	64	0.5188
I	---	137	0.2454
I	II	E28	0.4115
I	II	342	0.3802
I	II	517	0.1759
I	III	E19	0.2272
I	III	E21	0.2574
I	III	E20	0.3995
I	III	016	0.2406
I	III	E45	0.3884
I	III	611	0.3440
I	III	E19	0.3961
I	III	415	0.2536
I	III	430	0.3271
I	III	191	0.3781
I	III	418	0.1890
I	III	344	0.2933
I	III	435	0.2369
I	III	463	0.4129
I	III	146	0.2813
I	III	193	0.3632
I	III	65	1.2872



motorcycle track

<i>1707</i>	C9	0.2011
I	III	
I	LLL	E27
I	II	E2
I	II	317
I	III	E11
I	I	139
I	L	440
I	LL	C39
I	II	C7
I	IL	C12
I	III	E22
I	L	384
I	I	367
I	L	C40
I	II	C10
I	IL	C15
I	III	C30
I	I	A31
I	L	441
I	II	E3
I	IL	345
I	III	024
I	L	369
I	I	313
I	LL	019
I	LL	380
Low P _{Fe} Sulf. (High FeO)		020
(4) Low P _{Fe} Sulf. (High FeO)		1.5350
Low P _{Fe} Sulf. (High FeO)		1.0029
Low P _{Fe} Sulf. (High FeO)		0.1343
Low P _{Fe} Sulf. (High FeO)		0.3660
Low P _{Fe} Sulf. (High FeO)		0.2752
Low P _{Fe} Sulf. (High FeO)		0.2224

		531	0.3811
		423	0.4330
		031	0.2973
		512	0.5320
		330	0.3832
		57	0.4312
		035	0.5275
		046	0.5831
		182	0.3922
		016	0.4923
		029	0.6917
		111	0.3930
		114	0.3150
		58	0.5375
		120	0.3255
		124	0.4192
		125	0.2346
		513	0.2739
		143	0.3193
		538	0.7328
		55	1.0200
		129	0.7777
		55	0.3033
		59	1.0704
		57	0.3690
		54	0.9735
		413	0.3304
		122	0.4344
		04	0.3000
		51	0.5739
		03	1.2355
		35	0.0349

I	I	L	-----	C23.	0.7676
I	I	L	-----	E30.	0.3247
I	I	I	-----	36.	0.5581
I	I	II	-----	37.	0.3124
I	I	III	-----	325.	0.0012
I	I	LL	-----	38.	1.7473
I	I	LL	-----	485.	1.3709
I	I	L	-----	E34.	0.7130
I	I	I	-----	318.	0.2552
I	I	LL	-----	352.	0.5637
I	I	LL	-----	320.	1.4080
I	I	LL	-----	357.	0.5402
I	I	II	-----	345.	0.3543
I	I	LL	-----	356.	0.3085
I	I	I	-----	358.	0.3652
I	I	II	-----	325.	0.3122
I	I	II	-----	342.	0.3044
I	I	LLL	-----	C33.	1.0223
I	I	LL	-----	39.	1.0945
I	I	I	-----	34.	0.5278
I	I	II	-----	347.	0.3697
I	I	II	-----	229.	0.3737
I	I	LL	-----	228.	0.9081
I	I	II	-----	346.	1.3041
I	I	II	-----	349.	0.5908
I	I	LL	-----	355.	1.3249
I	I	I	-----	359.	0.9425
I	I	II	-----	362.	0.5205
I	I	II	-----	242.	0.3158
I	I	LL	-----	347.	1.5407
I	I	L	-----	354.	1.0085
I	I	II	-----	32.	1.4329
I	I	II	-----	33.	0.5443
I	I	II	-----	C30.	2.9573
I	I	I	-----	369.	0.7933
I	I	I	-----	356.	1.5499
I	I	II	-----	C37.	0.4805
I	I	III	-----	C31.	1.5879
I	I	II	-----	324.	2.3774
I	I	I	-----	323.	2.3103
I	I	II	-----	348.	2.3660
I	I	I	-----	334.	1.3243
I	I	II	-----	328.	1.4223
I	I	II	-----	E32.	2.9954
I	I	I	-----	324.	1.1580

high - high organic carbon

high hydrogen

high C/H

17/1 G2 (7) L1
L1 G1

	I	-----	320°	0.4060				
	II	-----	457°	0.5402				
	III	-----	345°	0.3543				
	IV	-----	356°	0.3085				
	V	-----	358°	0.5652				
	VI	-----	225°	0.3122				
	VII	-----	342°	0.3948				
	VIII	-----	233°	1.3223				
	IX	-----	30°	1.0945				
	X	-----	34°	0.5278				
	XI	-----	347°	0.3697				
	XII	-----	229°	0.4737				
	XIII	-----	228°	0.9081				
	XIV	-----	346°	0.3041				
	XV	-----	349°	0.3906				
	XVI	-----	355°	1.3249				
	XVII	-----	359°	0.4625				
	XVIII	-----	269°	0.5206				
	XIX	-----	242°	0.4158				
	XX	-----	247°	1.5407				
	XI	-----	354°	1.3065				
	XII	-----	32°	1.4329				
	XIII	-----	33°	0.5843				
	XIV	-----	230°	2.5573				
	XV	-----	365	0.7933				
	XVI	-----	256	0.5350				
	XVII	-----	237	0.3805				
	XVIII	-----	231	1.5870				
	XIX	-----	224	2.0754				
	XX	-----	223	2.3103				
	XI	-----	248	2.3660				
	XII	-----	273	1.3743				
	XIII	-----	229	1.4223				
	XIV	-----	232	2.3658				
	XV	-----	224	1.1660				
	XVI	-----	229	0.7923				
	XVII	-----	217	5.7508				
	XVIII	-----	218	3.4421				
	XIX	-----	177	4.3308				
	XX	-----	28	0.3348				
	XI	-----	247	3.4064				
	XII	-----	215					
				IDENT LEVEL				
10.050	9.550	7.050	5.550	4.050	2.550	1.050	-0.450	

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-----	20	1.3652
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-----	39	1.3241
-----	40	1.3217
-----	41	1.3193
-----	42	1.3167
-----	43	1.3141

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		10	16409
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		10	16441
		10	16457
		10	16473
		10	16489

PHENOGRAM FROM MATRIX COTGF200

27,200	23,200	19,200	15,200	11,200	7,200	3,200	-0,300	IDENT	LEVEL
								A1	0.4387
								A62	0.3004
								A61	0.5343
								A74	0.5427
								A39	0.5339
								A33	0.4955
								D24	0.5337
								A58	0.4494
								A67	0.5343
								A68	0.5888
								A79	1.0887
								A19	0.4731
								B1	1.0932
								A13	0.5606
								A24	0.5379
								D35	0.7079
								A51	0.4465
								D32	1.2878
								A52	0.4477
								A77	0.2693
								A79	0.1340
								A85	0.7084
								A76	0.5699
								D31	1.0403
								A92	0.5944
								A42	0.4989
								A96	0.7157
								D53	0.9200
								A37	0.2534
								D48	0.3678
								A39	0.4860
								D55	1.4857
								A54	0.7940
								A80	1.5488
								A45	0.6363
								D50	0.9238
								A46	1.3367
								E29	0.6509
								A31	1.4342

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	E33-	0.3983
	E36-	1.9146
	A15-	0.5905
	A30-	3.3367
	A36-	0.4725
	A40-	3.1236
	A43-	1.2444
	A46-	3.3756
	A25-	0.4901
	A47-	3.3807
	D21-	0.9866
	A17-	3.4722
	A48-	0.4135
	A69-	0.5813
	A50-	0.3112
	A21-	3.6346
	A86-	0.3720
	A94-	3.7347
	A53-	0.5127
	A74-	3.5341
	A61-	0.3915
	A32-	1.3293
	D2-	3.0412
	D61-	3.7408
	D34-	0.8034
	D13-	1.3737
	D4-	0.5128
	D6-	3.3034
	D40-	0.4534
	D63-	3.9544
	D33-	1.3048
	D34-	1.6376
	E37-	1.1757
	D38-	1.6638
	D61-	1.7726
	D3-	0.6370
	D4-	0.7001
	D30-	2.7366
	D25-	0.3111
	D39-	0.3715
	D41-	0.5678
	D44-	1.1306

2

	012-	0.5749
	049-	0.7391
	019-	1.3432
		0.7793
	013-	1.9579
	213-	1.9838
	A26	0.3469
	A43	0.3223
	A92	1.4649
	026	2.3293
	A43	0.5014
	93	0.7419
	83	0.5774
	353	0.9367
	310	0.5774
	341	1.2587
	34	1.1940
	348	0.3253
	356	1.1840
	36	0.5733
	37	0.7437
	325	0.3810
	347-	0.9825
	36	2.0000
	A27-	1.5096
	A31	0.1643
	A38-	0.7358
	A40	0.5537
	A90-	0.8405
	487	0.6031
	189-	1.2599
	341	0.6109
	014-	0.9110
	345	1.3036
	52	0.7036
	37	0.7462
	54-	0.8853
	216	0.5974
	220-	0.6684
	617	0.3743
	614-	0.4664
	328	0.3532

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	E33	0.3981
	E36	1.9146
	E42	0.4904
	E39	0.5496
	E27	0.7304
	E18	0.3483
	E29	1.3556
	E91	1.8611
	E37	0.2760
	E46	0.3773
	E41	0.2071
	E45	0.4946
	E40	0.8123
	E23	0.7513
	E20	0.3017
	E16	1.0401
	E21	0.5911
	E32	1.8280
	E13	0.2415
	E25	0.6477
	E43	0.5013
	E44	1.4001
	E12	1.9272
	E8	3.26e1
	E8	0.4332
	E60	0.7790
	E19	1.3193
	E75	1.3918
	E10	0.7792
	E65	1.1607
	E16	1.5351
	E56	1.3727
	E12	0.2593
	E11	1.1594
	E61	1.2501
	E5	2.2397
	E8	0.1486
	E20	0.5126
	E13	3.2635
	E12	1.1127
	E29	2.2863
	E57	1.3371
	E4	1.2948
	E6	0.7732
	E10	1.4437

	052	2.0637
	034	0.5981
	047	1.0946
	243	2.3600
	51	3.6048
	42	3.6478
	145	0.5123
	146	2.3877
	172	0.8050
	360	0.3370
	173	0.5581
	911	0.1041
	854	0.4470
	249	1.1084
	262	0.7923
	263	0.5777
	269	1.2513
	99	0.3591
	316	0.4203
	917	0.6835
	321	0.4714
	353	1.3581
	123	0.5375
	143	2.7032
	137	0.8953
	134	3.5552
	144	1.1594
	91	0.6428
	037	1.2348
	167	2.9643
	010	2.0552
	020	1.3537
	247	2.1512
	148	1.3153
	360	1.3441
	143	2.1955
	917	0.5859
	520	2.7942
	164	0.5090
	314	2.3184
	315	0.1859
	719	2.6247
	334	1.4342

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		533	0.3983
		536	1.9146
		415	0.5905
		514	1.580
		513	1.1514
		522	0.6646
		520	0.5011
		532	0.7563
		530	1.9315
		52	0.2867
		522	0.3991
		540	0.0
		530	0.5375
		523	0.3333
		543	0.5244
		555	0.7644
		535	0.3436
		542	0.5155
		546	1.3878
		524	0.7165
		531	0.5234
		536	1.1333
		512	0.3333
		527	0.5244
		551	0.5055
		533	0.3333
		557	0.0
		558	0.5042
		534	0.7444
		543	1.0977
		530	1.3777
		544	0.7118
		552	1.1115
		51	3.2729
		554	1.1600
		565	2.4698
		566	5.3337
		526	4.1555
		536	2.2333
		52	1.484
		527	3.1061
		517	1.3176
		59	2.6169
		44	0.6028
		46	3.7956
		511	1.4665
		514	0.3460

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	329	0.3390
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	342	0.3333
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	347	0.3679
	348	0.7155
	349	0.5239
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	352	0.5244
	353	0.3333
	354	0.3333
	355	0.3333
	356	0.3333
	357	0.3
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	359	0.7444
	360	1.0977
	361	1.3723
	362	0.7118
	363	1.1114
	364	1.2728
	365	1.1600
	366	2.4698
	367	5.3427
	368	4.3555
	369	0.3744
	370	1.1484
	371	3.1961
	372	1.3176
	373	2.0420
	374	0.5029
	375	3.7956
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	416	1.8171
	417	4.5640
	418	10.3493
	419	3.0781
	420	3.9314
	421	3.9121
	422	3.1496
	423	3.1230
	424	4.9014
	425	10.3871
	426	14.1346
	427	2.4303
	428	26.3437
	429	170
	430	62.725

27.200 23.200 19.200 15.200 11.200 7.200 3.200 -0.300 1.000 0.600

Table 2

Geochemical variables that best characterize the clusters generated by the Q-mode analysis of the total data set

<u>Cluster</u>	<u>Characterizing Variable(s)</u>
1	none (standard cluster)
2	Pyritic sulfur
3	Iron
4	Magnesium
5	Silica
6	Organic Carbon
7	Calcium-Magnesium

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Table 3

Mineralogical variables that best characterize the clusters generated by the Q-mode analysis of the total data set minus Core GG5.

<u>Cluster</u>	<u>Characterizing Variable(s)</u>
1	Pyrite
2	Orthoclase
3	Chlorite-Siderite
4	no Siderite
5	Illite
6	Quartz-Plagioclase-Calcite-Dolomite

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